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Bum-sik YOON et al.

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For: RECORDING MEDIUM WITH CONTENT STREAM DATA RECORDED THEREON, RECORDING APPARATUS, AND REPRODUCING APPARATUS THEREFOR

SUBMISSION OF ENGLISH TRANSLATION OF PRIOR FOREIGN APPLICATION IN ACCORDANCE WITH 37 C.F.R. § 1.78

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The applicants submit herewith an English translation of Korean Patent Application No. 2001-1233 and a statement from the translator that the translation is accurate in compliance with 37 C.F.R. §1.78.

Respectfully submitted,

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IN THE MATTER OF

U.S. Provisional Application No. 60/262,104

By Samsung Electronics Co., Ltd

I, Nak-hieon Kim, an employee of Y.P.Lee & Associates of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English language and that I am the translator of U.S. Provisional Application and certify that the following is to the best of my knowledge and belief a true and correct translation.

Signed this 21th day of March 2001

Kim Nak-Hieon

Nak-hieon Kim

RECORDING MEDIUM CONTAINING CONTENT STREAM DATA RECORDED THEREON, RECORDING APPARATUS, AND REPRODUCING APPARATUS THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to recording and reproducing content stream data, and more particularly, to a recording medium containing content stream data recorded thereon, a recording apparatus, and a reproducing apparatus thereof.

2. Description of the Related Art

Each of various contents, such as movies, music, etc., are generally referred to as a program.

FIG. 1 is the structure of the conventional program data.

Generally, content stream data forming a program is formed by one stream object (SOB). Referring to FIG. 1, an SOB is formed of a chain in which one or more stream object units (SOBU) are linked. An SOBU is a unit for recording and editing data, and a predetermined size of data. However, since the input and/or output speeds of data streams forming a program can change in recording and/or reproducing, the corresponding SOBU lengths on a time axis can be different from one another.

Meanwhile, an SOB contains one or more stream packs (S_PCK). That is, the SOB is formed by content stream data in which a plurality of stream packs stand in a row. Stream packs standing in a row are divided so that each divided unit has an identical predetermined size, and the resulting divided unit is a stream object unit (SOBU). Therefore, an SOBU can contain a plurality of stream packs, but it is possible that the start and end of the first or the last stream pack do not match the start or the end of the SOBU. That is, a stream pack can stretch over two SOBUs. All SOBUs contained in the same SOB have the same number stream packs.

A stream pack is formed by a pack header and a stream packet. A stream packet contains one or more application packets (AP_PKT). The application packet (AP_PKT) is a piece of a bit stream which is input when a recording apparatus records data, or output when a reproducing apparatus reproduces data. Therefore, in

front of an application packet a time stamp (ATS) is located. The ATS means reproducing time information of the application packet located at the back of the ATS.

Meanwhile, to arbitrarily access a program recorded as shown in FIG. 1, search information which is separately made is generally used. Search information can include information on the location of certain data in a program, program reproducing time information, and program recording time information. Search information can have various formats depending on application fields, however, to reduce the amount of information and enable quick search, a hierarchical structure is frequently used to indicate data in the program.

If search information forming a program is formed of three layers of a cell, an SOB, and SOBUs, the search information includes information on what a cell or cells correspond to a predetermined program, information on what an SOB or SOBs correspond to a predetermined cell, and information on what an SOBU or SOBUs correspond to a predetermined SOB. Particularly, information on what an SOBU or SOBUs correspond to an SOB is referred to as a mapping list (MAPL).

A mapping list contains an incremental application packet arrival time (IAPAT), which indicates the duration of a corresponding SOBU. According to DVD-SR Draft 0.9, the arrival time of an application packet contained in the corresponding SOBU is needed for obtaining an IAPAT.

Meanwhile, according to DVD-SR Draft 0.9, the size of an application packet (AP_PKT_SZ) satisfies $AP\_PKT\_SZ \leq 2018*[SOBU\_SZ] - 2$. Here, SOBU_SZ denotes the size of an SOBU. This expression is made considering that at least 30 bytes are needed for a pack header and 2 bytes are needed for a header extension and a stuffing packet defined in a stream packet, assuming that one SOBU has a number of stream packs equal to the number of SOBU_SZs. That is, it is because the maximum area for application packets is the result obtained by subtracting 30 bytes from 2048 bytes for one SOBU and then again subtracting 2 bytes from the resulting 2018 bytes.

However, according to the above scope of the size of an application packet, a case where no ATS exist in one SOBU occurs.

FIG. 2 illustrates a case where an application time stamp (ATS) does not exist in a stream object unit (SOBU).

If the last stream pack contained in an SOB is located as shown in FIG. 2, the first byte forming an ATS is not included in SOBU #M-1, and since only a part of an application packet formed in the last stream pack is located in SOBU #M, no included ATS exist.

As this, according to the size of an application packet defined in DVD-SR Draft 0.9, a case where a corresponding ATS does not exist, such as in SOBU #M-1 or SOBU #M, occurs. The IAPAT of an SOBU which has no corresponding ATS cannot be obtained, and therefore, a mapping list formed of the IAPAT as search information cannot be obtained. Accordingly, it is impossible to search a program.

Particularly, in DVD-SR Draft 0.9, it is prescribed that in a case where the last SOBU of an SOB does not have a corresponding ATS, the IAPAT be obtained using a copy of the ATS of the last application packet. However, according to the rule for obtaining an IAPAT, which is prescribed in DVD-SR Draft 0.9, both IAPAT(M-1), which is the IAPAT value of SOBU #M-1, and IAPAT(M), which is the IAPAT value of SOBU#M, are "0", and therefore, program search based on a mapping list formed of IAPAT can not be carried out correctly. For, according to the prescription of DVD-SR Draft 0.9, IAPAT(i) should meet the following conditions:

1<=IAPAT(i) <212, i=1

1<=IAPAT(i) <212-1, 1<i<M

0<=IAPAT(i) <212-1, i=M

However, referring to FIG. 3, IAPAT(M-1) is "0" and does not satisfy the conditions.

SUMMARY OF THE INVENTION

To solve the above problems, it is an object of the present invention to provide a recording medium containing content stream data recorded thereon, the content stream data having a data structure, in which a stream object unit (SOBU) included in a stream object (SOB) has a corresponding application time stamp (ATS) so that program search based on a mapping list can be correctly performed, a recording apparatus and a reproducing apparatus thereof.

To accomplish the above object of the present invention, there is provided a recording medium, on which an SOB containing at least one or more SOBUs, in which

content stream data is recorded, and to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, is recorded, and the recording medium in which each of the SOBUs excluding the last SOBU has at least one entire ATS.

It is preferable that the size of the application packet is small enough to include at least one entire ATS and satisfies the following expression:

$$AP\_PKT\_SZ \leq 2018*[SOBU\_SZ]-6$$

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU.

If the expression is generalized, the resulting expression is as the following expression:

$$AP\_PKT\_SZ \leq SPayload\_SZ*[SOBU\_SZ] - [N\_AHE + N\_SByte + ATS\_SZ]$$

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

The recording medium further includes a mapping list (MAPL) having an incremental application packet arrival time (IAPAT) indicating the duration of a corresponding SOBU, as search information for indicating what an SOBU or SOBUs are included in a certain SOB.

To accomplish another object of the present invention, there is also provided a recording medium, on which an SOB containing at least one or more SOBUs, in which content stream data is recorded, and to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, is recorded, and the recording medium in which an SOBU having no ATS among the SOBUs includes a stuffing packet for correction, the stuffing packet which has a predetermined ATS, is contiguously recorded.

It is preferable that each of the SOBUs excluding the last SOBU includes at least one entire ATS, the stuffing packet for correction is continuously recorded to the last application packet (A_PKT) of an SOB so as to be included in the last SOBU of the SOB, and the ATS contained in stuffing packet for correction has a value obtained by adding an integer to the ATS contained in the last stream pack.

It is preferable that the stuffing packet for correction further includes a payload, in which predetermined data is recorded, or no data is recorded. It is more preferable that "0" is recorded in the payload.

Also, it is preferable that the size of the application packet is small enough for each of the SOBUs excluding the last SOBU to include at least one entire ATS, and satisfies the following expression:

$$AP\_PKT\_SZ \leq 2018*[SOBU\_SZ]-6$$

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU. If the expression is generalized, the resulting expression is as the following expression:

$$AP\_PKT\_SZ \leq SPayload\_SZ*[SOBU\_SZ] - [N\_AHE + N\_SByte + ATS\_SZ]$$

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

The recording medium further includes a mapping list (MAPL) having an incremental application packet arrival time (IAPAT) indicating the duration of a corresponding SOBU, as search information for indicating waht an SOBU or SOBUs are included in a certain SOB.

To accomplish another object of the present invention, there is also provided a recording apparatus for recording an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, the recording apparatus having a control unit for generating a mapping list as search information; a clock generation unit for generating a clock value; a buffer unit for adding the clock value provided from

the clock generating unit to received content stream data, and outputting the content stream data at an appropriate speed by buffering the content stream data;

a stream object unit (SOBU) generating unit for packing the content stream data output from the buffer unit and generating SOBUs so that the each of the SOBUs, excluding the last SOBU, includes at least one entire ATS; and a recording unit for recording the SOBUs generated by the SOBU generating unit and the mapping list generated by the control unit.

It is preferable that the size of the application packet is small enough for each of the SOBUs excluding the last SOBU to include at least one entire ATS, and satisfies the following expression:

$$AP\_PKT\_SZ \leq 2018*[SOBU\_SZ]-6$$

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU. If the expression is generalized, the resulting expression is as the following expression:

$$AP\_PKT\_SZ \leq SPayload\_SZ*[SOBU\_SZ] - [N\_AHE + N\_SByte + ATS\_SZ]$$

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

The mapping list includes an incremental application packet arrival time (IAPAT) indicating the duration of a corresponding SOBU, as search information for indicating a corresponding SOBU of a corresponding SOB.

To accomplish another object of the present invention, there is also provided a recording apparatus for recording an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, the recording apparatus having a control unit for generating a mapping list as search information; a clock generation unit for generating a clock value; a buffer unit for adding the clock value provided from the clock generating unit to received content stream data, and outputting the content stream data at an appropriate speed by buffering the content stream data; a stream

object unit (SOBU) generating unit for including a stuffing packet for correction having a predetermined ATS into an SOBU, which has not corresponding ATS, in generating SOBUs; and a recording unit for recording the SOBUs generated by the SOBU generating unit and the mapping list generated by the control unit.

It is preferable that all SOBUs excluding the last SOBU contains at least one entire ATS, the SOBU generating unit includes the stuffing packet for correction into the last SOBU, and the recording unit contiguously records the stuffing packet after the last application packet (A_PKT) contained in the SOB.

The ATS contained in the stuffing packet for correction has a value obtained by adding an integer to the ATS contained in the last stream pack, and the stuffing packet for correction further includes a payload, in which predetermined data is recorded, or no data is recorded.

It is preferable that the recording unit records "0" in the payload.

To accomplish another object of the present invention, there is also provided a recording apparatus for recording an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, the recording apparatus having a clock generation unit for generating a clock value; a buffer unit for adding the clock value provided from the clock generating unit to received content stream data, and outputting the content stream data at an appropriate speed by buffering the content stream data; an SOBU generating unit for generating SOBUs by packing content stream data output from the buffer unit; a control unit for generating a mapping list as search information by regarding an SOBU, which has no corresponding ATS, having a predetermined ATS; and a recording unit for recording the SOBUs generated by the SOBU generating unit and the mapping list generated by the control unit.

It is preferable that the control unit generates a mapping list containing an IAPAT obtained by regarding a value, which is obtained by adding an integer to the ATS of the last stream pack contained in the SOB, as the predetermined ATS.

It is preferable that the size of the application packet is small enough for each of the SOBUs excluding the last SOBU to include at least one entire ATS,

and satisfies the following expression:

AP_PKT_SZ≤ 2018*[SOBU_SZ]-6

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU. If the expression is generalized, the resulting expression is as the following expression:

AP_PKT_SZ≤ SPayload_SZ*[SOBU_SZ] - [N_AHE + N_SByte + ATS_SZ]

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

To accomplish another object of the present invention, there is also provided a reproducing apparatus for reproducing content stream data from a recording medium, on which an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, is recorded, in which the size of application packet is small enough so that each of the SOBUs excluding the last SOBU has at least one entire ATS, the reproducing apparatus having a reading unit for reading the mapping list and the SOBU as search information; a control unit for controlling the reading unit so as to read a corresponding SOBU, referring to the mapping list read by the reading unit; a clock generating unit for generating a clock value; an SOBU analyzing unit for extracting content stream data by analyzing the SOBU read from the reading unit; and a buffer unit for outputting the content stream data provided from the SOBU analyzing unit, at an appropriate speed by buffering the content stream data based on a clock value provided by the clock generating unit.

It is preferable that the size of the application packet satisfies the following expression:

AP_PKT_SZ≤ 2018*[SOBU_SZ]-6

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU. If the expression is generalized, the resulting expression is as the following expression:

AP_PKT_SZ≤ SPayload_SZ*[SOBU_SZ] - [N_AHE + N_SByte + ATS_SZ]

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

The mapping list includes an incremental application packet arrival time (IAPAT) indicating the duration of a corresponding SOBU, as search information for indicating a corresponding SOBU of a corresponding SOB.

To accomplish another object of the present invention, there is also provided a reproducing apparatus for reproducing content stream data from a recording medium, on which an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, is recorded, in which an SOBU, which has no corresponding ATS, contains a stuffing packet for correction, having a predetermined ATS, the reproducing apparatus having a reading unit for reading the mapping list and the SOBU as search information; a control unit for controlling the reading unit so as to read a corresponding SOBU, referring to the mapping list read by the reading unit; a clock generating unit for generating a clock value; an SOBU analyzing unit for extracting content stream data by analyzing the SOBU read from the reading unit by the control unit; and a buffer unit for outputting the content stream data provided from the SOBU analyzing unit, at an appropriate speed by buffering the content stream data based on a clock value provided by the clock generating unit.

It is preferable that the ATS contained in the stuffing packet for correction has a value obtained by adding an integer to the ATS contained in the last stream pack.

It is preferable that the stuffing packet for correction further includes a payload, in which predetermined data is recorded, or no data is recorded.

To accomplish another object of the present invention, there is also provided a reproducing apparatus for reproducing content stream data from a recording medium, on which an SOB containing at least one or more SOBUs, to each of which one or more stream packs standing in a row are divided into units of a predetermined size

and the divided units are sequentially assigned, in which each of the stream packs includes an application time stamp (ATS) and an application packet (A_PKT) into which content stream data is packed, is recorded, in which a mapping list generated by regarding an SOBU, which has no corresponding ATS, having a virtual ATS, is recorded as search information, the reproducing apparatus having a reading unit for reading the mapping list and the SOBU as search information; a control unit for controlling the reading unit so as to read a corresponding SOBU, referring to the mapping list read by the reading unit; a clock generating unit for generating a clock value; an SOBU analyzing unit for extracting content stream data by analyzing the SOBU read from the reading unit by the control unit; and a buffer unit for outputting the content stream data provided from the SOBU analyzing unit, at an appropriate speed by buffering the content stream data based on a clock value provided by the clock generating unit.

The mapping list contains an IAPAT generated by regarding a value, which is obtained by adding an integer to the ATS of the last stream pack contained in the SOB, as the virtual ATS.

It is preferable that the size of the application packet is small enough for each of the SOBUs excluding the last SOBU to include at least one entire ATS, and satisfies the following expression:

$$AP\_PKT\_SZ \leq 2018*[SOBU\_SZ]-6$$

Here, AP_PKT_SZ denotes the size of an application packet, and SOBU_SZ denotes the size of an SOBU. If the expression is generalized, the resulting expression is as the following expression:

$$AP\_PKT\_SZ \leq SPayload\_SZ*[SOBU\_SZ] - [N\_AHE + N\_SByte + ATS\_SZ]$$

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG. 1 is the structure of the conventional program data;

FIG. 2 illustrates a case where an application time stamp (ATS) does not exist in a stream object unit (SOBU);

FIG. 3 illustrates the conventional method to cope with a case where an ATS does exist in the last SOBU;

FIG. 4 is the data structure according to a first embodiment of the present invention;

FIG. 5 is the data structure according to a second embodiment of the present invention;

FIG. 6 is a block diagram of a recording apparatus according a preferable embodiment of the present invention;

FIG. 7 is a block diagram of a reproducing apparatus according a preferable embodiment of the present invention; and

FIG. 8 is a block diagram of a recording and reproducing apparatus according a preferable embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiments of the present invention will be described in detail with reference to the attached drawings. The present invention is not restricted to the following embodiments, and many variations are possible within the spirit and scope of the present invention. The embodiments of the present invention are provided in order to more completely explain the present invention to anyone skilled in the art.

A recording medium according to the present invention is a re-writable recording medium, and a user can directly record and edit a program formed of content stream data. Recording content stream data means to record input content stream data as it is without encoding. That is, audio or video stream data such as music or movies is received, buffered, packed in predetermined recording units, and recorded in the recording medium.

Digital Versatile Disc-Stream Recording (DVD-SR), which is a recording medium according to the present embodiment, includes a program recorded in a stream object (SOB), and search information for program navigation.

Here, as in the prior art, the SOB means a program, such as music or a movie, which is recorded in the form of content stream data, and includes one or more stream packs (S_PCK). Stream packs standing in a row are divided so that each divided unit has an identical predetermined size, and the resulting divided unit is a stream object unit (SOBU). Therefore, an SOBU can contain a plurality of stream packs, but it is possible that the start and end of the first or the last stream pack do not match the start or the end of the SOBU. That is, a stream pack can stretch over two SOBUs. All SOBUs contained in the same SOB have the same number stream packs.

A stream pack is formed by a pack header and a stream packet. A stream packet contains one or more application packets (AP_PKT). The application packet (AP_PKT) is a piece of a bit stream which is input when a recording apparatus records data, or output when a reproducing apparatus reproduces data. Therefore, in front of an application packet a time stamp (ATS) is located. The ATS means reproducing time information of the application packet located at the back of the ATS.

Meanwhile, search information has a hierarchical structure containing information on what is a cell corresponding to a predetermined program, what is an SOB corresponding to a predetermined cell, and what is an SOBU corresponding to a predetermined SOB. Particularly, information on what is an SOBU corresponding to an SOB is referred to as a mapping list (MAPL). A mapping list contains an incremental application packet arrival time (IAPAT) indicating the duration of a corresponding SOBU. A rule for obtaining an IAPAT will be explained later.

Meanwhile, each of the SOBUs, excluding the last SOBU, contained in a predetermined SOB according to the present invention has at least one entire ATS. That is, the first byte of at least one ATS is contained in a corresponding SOBU. Because the size of an application packet according to the present invention satisfies the following expression:

$$AP\_PKT\_SZ \leq 2018*[SOBU\_SZ]-6$$

That is, as described in the explanation of the prior art, considering that at least 30 bytes are needed for a pack header and 2 bytes are needed for a header

extension and a stuffing packet defined in a stream packet, assuming that one SOBU has a number of stream packs equal to the number of SOBU_SZs, 2018*[SOBU_SZ]-2 is the remaining area. However, if considering the size of an ATS is 4 bytes, the size of an application packet is made to be less than or equal to 2018*[SOBU_SZ]-2, each of all SOBUs excluding the last SOBU contains the first byte of at least one ATS.

If the expression is generalized based on variables defined in DVD-SR Draft 0.9, the resulting expression is as the following expression:

$$AP\_PKT\_SZ \leq SPayload\_SZ*[SOBU\_SZ] - [N\_AHE + N\_SByte + ATS\_SZ]$$

Here, ATS_SZ denotes the byte size of an ATS, SPayload_SZ denotes the size of data space for containing information, excluding a fixed header area of S_PCK, N_AHE denotes the number of application header extension of a corresponding SOBU, and N_SByte denotes the number of stuffing bytes of a corresponding SOBU.

Meanwhile, a data structure for making the last SOBU have an IAPAT according to the present invention can be implemented in the two embodiments which will now be explained.

First, the first embodiment of a data structure for making the last SOBU have an IAPAT will now be explained.

FIG. 4 is the data structure according to the first embodiment of the present invention.

Referring to FIG. 4, an SOB is formed of an SOBU chain, in which M SOBUs are connected. Since the size of an application packet is as described above according to the present invention, each of SOBUs excluding the last SOBU contains the first byte of at least one ATS. That is, SOBU #M-1 contains the first byte of ATS #N.

Meanwhile, SOBU #M does not contains ATS, but contains all or part of application packet AP_PKT #N. That is, when an ATS contained in the last SOBU, SOBU #M, does not exist, a stuffing packet for correction 300 is recorded after the last application packet AP_PKT #N, according to the present embodiment. The stuffing packet for correction 300 is formed of ATS #N+1 301 and a payload 302. Here, ATS #N+1 301 has a value obtained by adding integer "1" to ATS #N.

In the payload, "0" is recorded according to the present embodiment. However, a value obtained by adding any integer among 2, 3, 4,..., to ATS #N can be recorded as ATS #N+1 301. Meanwhile, since the SOB ends with the substantially last application packet AP_PKT #N, and data recorded after the last application packet AP_PKT #N is not read in reproducing the SOB, data format and content recorded in the payload 302 can change in various ways when necessary. As the case may be, no data is recorded in the payload 302.

Next, the data structure for making the last SOBU have an IAPAT according to the second embodiment will now be explained.

FIG. 5 is the data structure according to the second embodiment of the present invention.

Referring to FIG. 5, an SOB is formed of an SOBU chain, in which M SOBUs are connected. Since the size of an application packet is as described above according to the present invention, each of SOBUs excluding the last SOBU contains the first byte of at least one ATS. That is, SOBU #M-1 contains the first byte of ATS #N.

At this time, as described above referring to FIG. 4, ATS #N+1 has a value obtained by adding integer "1" to ATS #N, but is not actually recorded. That is, in calculating an IAPAT value required for recording a mapping list as search information, recorded ATS #N+1 is not actually read, but ATS #N is read and then a value obtained by adding "1" to ATS #N is just regarded as ATS #N+1. However, the IAPAT obtained by regarding the value obtained by adding "1" to ATS #N as ATS #N+1 is recorded in the mapping list as search information. Meanwhile, as in the first embodiment, ATS #N+1 can be a value obtained by adding any integer among 2, 3, 4, ..., to ATS #N+1.

According to the first embodiment and the second embodiment described above referring to FIGS. 4 and 5, the first ATS of SOBU #M-1 is ATS #N and the first ATS of SOBU #M is ATS #N+1. Since the first ATSs are different to each other, the IAPAT of (M-1)-th SOBU is not "0". That is, according to the rules defined in DVD-SR Draft 0.9, the IAPAT values of all SOBUs can be correctly obtained. Therefore, since each SOBU has an IAPAT value which can be distinguished from other IAPAT,

program search referring to a mapping list can be performed smoothly without an error.

Meanwhile, according to DVD-SR Draft 0.9, the rule for obtaining an IAPAT is as follows. For i-th SOBU, SOBU(i), excluding SOBU #M, when an SOB contains M SOBUs, a value obtained by accumulating IAPATs from the first IAPAT, IAPAT(1) to the i-th IAPAT, IAPAT(i), should be greater than or equal to the arrival time of the first application packet of SOBU(i+1), and less than a value obtained by adding "1" to the arrival time of the first application packet of SOBU(i+1). At this time, an IAPAT has an integer value and the initial value of an IAPAT is "0". This can be expressed by the following expression:

SOBU_S_APAT(i+1) <= SUM_IAPAT(i) < SOBU_S_APAT(i+1) + 1

Here, SOBU_S_APAT(i+1) denotes the arrival time of the first application packet contained in SOBU #i+1, and SUM_IAPAT(i) denotes a value obtained by accumulating the IAPATs of SOBU#i and all preceding SOBUs.

Also, as for SOBU #M, a value obtained by accumulating all IAPATs is greater than the arrival time of the last application packet contained in the SOBU #M, and less than or equal to a value obtained by adding "1" to the arrival time of the last packet contained in the SOBU #M. This can be expressed by the following expression:

SOBU_E_APAT(M) < SUM_IAPAT(M) <= SOBU_E_APAT(M) +1

Here, SOBU_E_APAT(M) denotes the arrival time of the last application packet contained in SOBU #M.

FIG. 6 is a block diagram of a recording apparatus according a preferable embodiment of the present invention.

Referring to FIG. 6, the recording apparatus 5 records contents such as music or movies in one SOB having the data structure described above, and has a buffer unit 51, a clock generating unit 52, an SOBU generating unit 53, a recording unit 55, and a control unit 56. The buffer unit 51 receives content streams from the outside and output the content streams at an appropriate speed by buffering the content streams based on the clock values provided from the clock generating unit 52. The SOBU generating unit generates SOBUs by packing content streams. The recording unit 55 records SOBUs and search information such as a mapping list in an optical

disc 500 based on controls from the control unit 56. The control unit 56 generates a mapping list and provides the mapping list to the recording unit 55, while controls the entire recording apparatus 5 so that content streams are recorded in the optical recording medium 500.

Based on the structure described above, first, the recording method according to a first embodiment of the present invention will now be explained.

When content streams are input to the buffer unit 51 from such an application apparatus as a set-top-box, and a user pushes a recording button (not shown) of the recording apparatus, the control unit 56 resets the clock generating unit 52. Then, the clock generating unit 52 generates clock values from "0" and provides the clock values to the buffer unit 51.

The buffer unit 51 attaches the clock values received from the clock generating unit 52 to the received content streams, and outputs the received content streams at an appropriate speed by buffering the content streams. The SOBU generating unit 53 packs the content streams received from the buffer unit 51, and generates SOBUs. The generated SOBUs are transmitted to the recording unit 55, and the recording unit 55 records the received SOBUs in the optical disc 500 based on the controls from the control unit 56.

At this time, as shown in FIG. 4, if SOBU #M-1, which is the second SOBU from the end of the SOB, contains at least one entire ATS, and SOBU #M, which is the last SOBU, does not contain an ATS, a stuffing packet for correction 300 is recorded continuously after the last application packet AP_PKT #N. A value obtained by adding integer "1" to ATS #N is recorded as ATS #N+1 of the present embodiment. "0" is recorded in the payload according to the present embodiment.

Also, the recording unit 55 records the mapping list, provided form the control unit 56, as navigation data for search information recording area of the optical disc 500.

The recording method according to a second embodiment of the present invention will now be explained.

When content streams are input to the buffer unit 51 from such an application apparatus as a set-top-box, and a user pushes a recording button (not shown) of the recording apparatus, the control unit 56 resets the clock generating unit 52. Then, the

clock generating unit 52 generates clock values from "0" and provides the clock values to the buffer unit 51.

The buffer unit 51 attaches the clock values received from the clock generating unit 52 to the received content streams, and outputs the received content streams at an appropriate speed by buffering the content streams. The SOBU generating unit 53 packs the content streams received from the buffer unit 51, and generates SOBUs. The generated SOBUs are transmitted to the recording unit 55, and the recording unit 55 records the received SOBUs in the optical disc 500 based on the controls from the control unit 56.

Also, the recording unit 55 records the mapping list, provided form the control unit 56, as navigation data for search recording area of the optical disc 500. Here, the mapping list is generated by the control unit 56 and provided to the recording unit 55. More specifically, as shown in FIG. 5, the control unit 56 reads ATS #N, regards a value obtained by adding "1" to ATS #N according to the present embodiment, as ATS #N+1, and records an IAPAT value, which is obtained by the rule described above, based on ATS #N+1, in the mapping list. That is, ATS #N+1 has a value obtained by adding integer "1" to ATS #N, but the value is not a value actually recorded as data, but a virtual value used by the control unit 56 in calculating an IAPAT value forming the mapping list. Meanwhile, ATS #N+1 can be a value obtained by adding any integer among 2, 3, 4, ..., to ATS #N.

FIG. 7 is a block diagram of a reproducing apparatus according a preferable embodiment of the present invention.

Referring to FIG. 7, the reproducing apparatus reproduces contents from an optical disc 600 on which data having the data structure described referring to FIGS. 4 through 6 is recorded, and has a control unit 66, a reading unit 65, an SOBU analyzing unit 64, a clock generating unit 62, and a buffer unit 61.

The control unit decodes various control information including a mapping list and controls the entire reproducing apparatus so that contents recorded on the optical recording medium 600 can be reproduced based on user's requirements.
The reading unit 65 reads data from the optical recording medium 600. The SOBU analyzing unit 64 extracts content stream data forming contents by analyzing read

SOBUs, and outputs content stream data at an appropriate speed by buffering content stream data based on the clock values provided from the clock generating unit 62.

Based on the structure described above, first, the reproducing method according to a first embodiment of the present invention will now be explained.

If a user requests to reproduce predetermined contents by pushing a reproducing button (not shown) of the reproducing apparatus, the control unit 66 commands the reading unit 65 to read search information, including a mapping list, recorded in the optical recording medium 600, receives search information, including the mapping list, provided from the reading unit 65, and finds out the corresponding SOB or the corresponding SOBU. At this time, as shown in FIG. 4, even if each of SOBUs contained in the SOB, excluding the last SOBU, has at least one entire ATS and ATS contained in the last SOBU does not exist, a stuffing packet for correction 300, containing ATS #N+1 having a value obtained by adding integer "1" to ATS #N following the last application packet AP_PKT #N, is recorded in the optical recording medium 600, and a mapping list having an IAPAT obtained based on the stuffing packet for correction 300 is recorded as search information. Therefore, searching for contents and reproducing contents in a desired location can be smoothly performed.

Meanwhile, the control unit 66 resets the clock generating unit 62. Then, the clock generating unit 62 generates clock values from "0" and provides the clock values to the buffer unit 61.

The reading unit 65 reads recorded contents and provides the contents to the SOBU analyzing unit 64. The SOBU analyzing unit 64 extracts content stream data from the provided SOBU. The buffer unit 61 outputs the corresponding content stream data at a time when the clock value provided from the clock generating unit 62 becomes the same as the clock value attached to the received content stream data.

Next, the reproducing method according to a second embodiment of the present invention will now be explained.

If a user requests to reproduce predetermined contents by pushing a reproducing button (not shown) of the reproducing apparatus, the control unit 66 commands the reading unit 65 to read search information, including a mapping list, recorded in the optical recording medium 600, receives search information, including the mapping list, provided from the reading unit 65, and finds out the corresponding

SOB or the corresponding SOBU. At this time, as shown in FIG. 5, even if each of SOBUs contained in the SOB, excluding the last SOBU, has at least one entire ATS and ATS contained in the last SOBU does not exist, a mapping list containing an IAPAT obtained by regarding ATS #N+1, which is obtained by adding integer "1" to ATS #N, being included in SOB #M, is recorded as search information, and therefore searching for contents and reproducing contents at a desired location can be performed.

Meanwhile, the control unit 66 resets the clock generating unit 62. Then, the clock generating unit 62 generates clock values from "0" and provides clock values to the buffer unit 61.

The reading unit 65 reads recorded contents and provides the contents to the SOBU analyzing unit 64. The SOBU analyzing unit 64 extracts content stream from the provided SOBU. The buffer unit 61 outputs the corresponding content stream at a time when the clock value provided from the clock generating unit 62 becomes the same as the clock value attached to the received content stream data.

FIG. 8 is a block diagram of a recording and reproducing apparatus according a preferable embodiment of the present invention.

Referring to FIG. 8, the recording and reproducing apparatus 7 is implemented by combining the recording apparatus 5 of FIG. 6 and the reproducing apparatus 6 of FIG. 7 in one unit, and has a recording/reading unit 75, an SOBU generating unit 73, an SOBU analyzing unit 74, a buffer unit 71, a clock generating unit 72, and a control unit 76, so that in recording, each of content such as music and a movie is recorded as one SOB having the data structure described above, and in reproducing, contents are reproduced from an optical disc 700 on which data having the structure explained referring to FIGS. 4 through 6, are recorded.

The buffer unit 71, in recording, receives content stream data from the outside, and outputs the content stream data at an appropriate speed by buffering the content stream data based on clock values provided from the clock generating unit 72, and in reproducing, outputs content stream data at an appropriate speed by buffering the content stream data based on clock values provided from the clock generating unit 72.

The SOBU generating unit 73 generates SOBUs by packing content stream data. The SOBU analyzing unit 74 extracts content stream data forming contents by analyzing SOBUs.

The recording/reading unit 75, in recording, records SOBUs and search information such as a mapping list on the optical disc 700 based on the control of the control unit 76 and content stream data packed in SOBUs, and in reproducing, reads search information, including a mapping list, or SOBUs recorded in the optical disc 700 at the request of the control unit 76.

The control unit 76, in recording, generates a mapping list and provides the mapping list to the recording/reading unit 75 and controls the entire recording and reproducing apparatus 7 so that content stream data is recorded on the optical disc 700, and in reproducing, decodes various control information, including the mapping list, and controls the entire recording and reproducing apparatus so that contents recorded on the optical disc 700 can be reproduced.

The recording method and reproducing method of the recording and reproducing apparatus having the structure described above are the same as those of the above-described recording apparatus and reproducing apparatus, respectively, and the explanation will be omitted.

According to the methods and apparatuses above described, the IAPAT values of all SOBUs can be correctly obtained, and therefore, program search referring to a mapping list can be smoothly performed without an error.

Abstract

A recording medium containing content stream data recorded thereon, a recording apparatus, and a reproducing apparatus thereof. A stream object having at least one stream object unit (SOBU) is recorded on the recording medium, one or more stream packs (S_PCK), which stand in a row and in each of which content stream data is recorded, are assigned to the stream object unit (SOBU) after divided into a predetermined size, and each of the stream packs contains an application packet (A_PKT) packing an application time stamp (ATS) and content stream data. Here, excluding the last SOBU, each of the SOBUs contains at least one entire ATS. By doing so, the incremental application packet arrival time (IAPAT) of each of all the SOBUs can be correctly obtained, and therefore program search referring to a mapping list can be smoothly performed without error.

FIG. 1 (PRIOR ART)

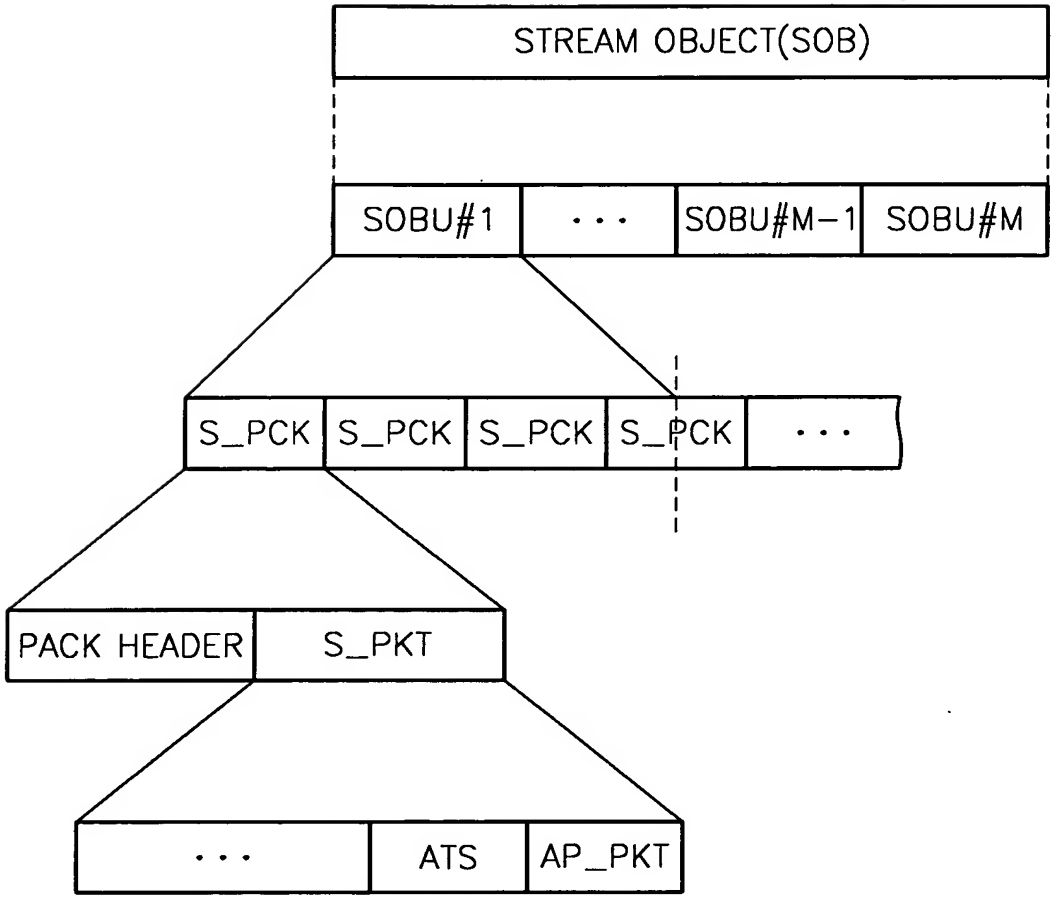


FIG. 2 (PRIOR ART)

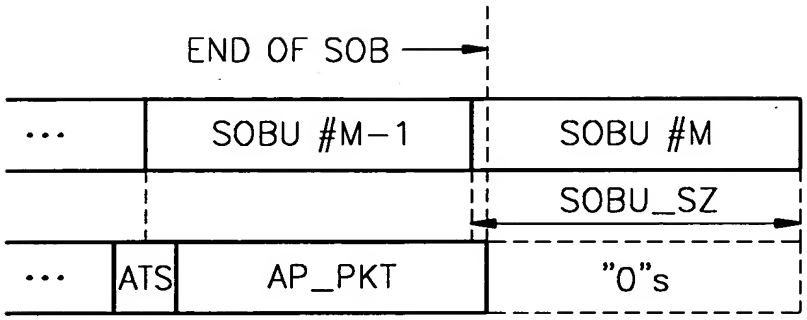


FIG. 3 (PRIOR ART)

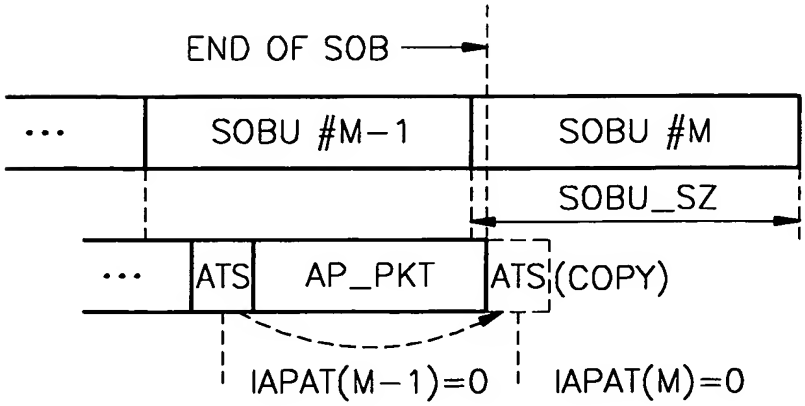


FIG. 4

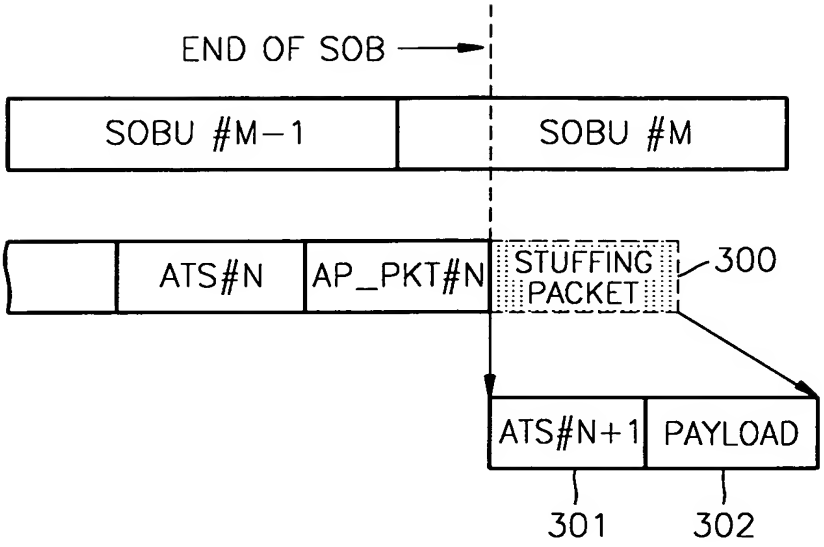

END OF SOB
SOBU #M−1
SOBU #M
ATS#N
AP_PKT#N
STUFFING PACKET
300
ATS#N+1
PAYLOAD
301
302

FIG. 5

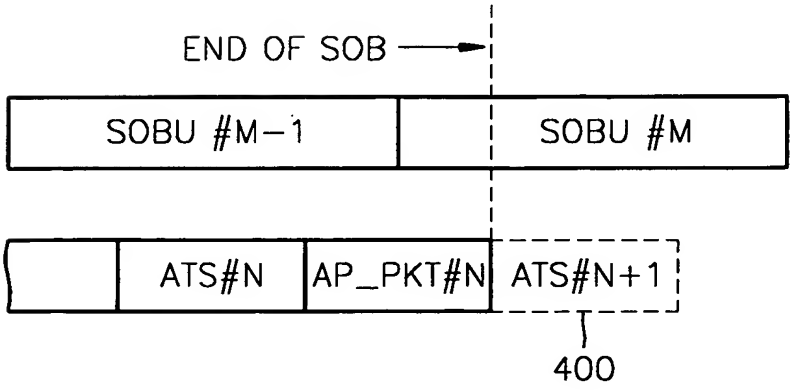

END OF SOB
SOBU #M−1
SOBU #M
ATS#N
AP_PKT#N
ATS#N+1
400

FIG. 6

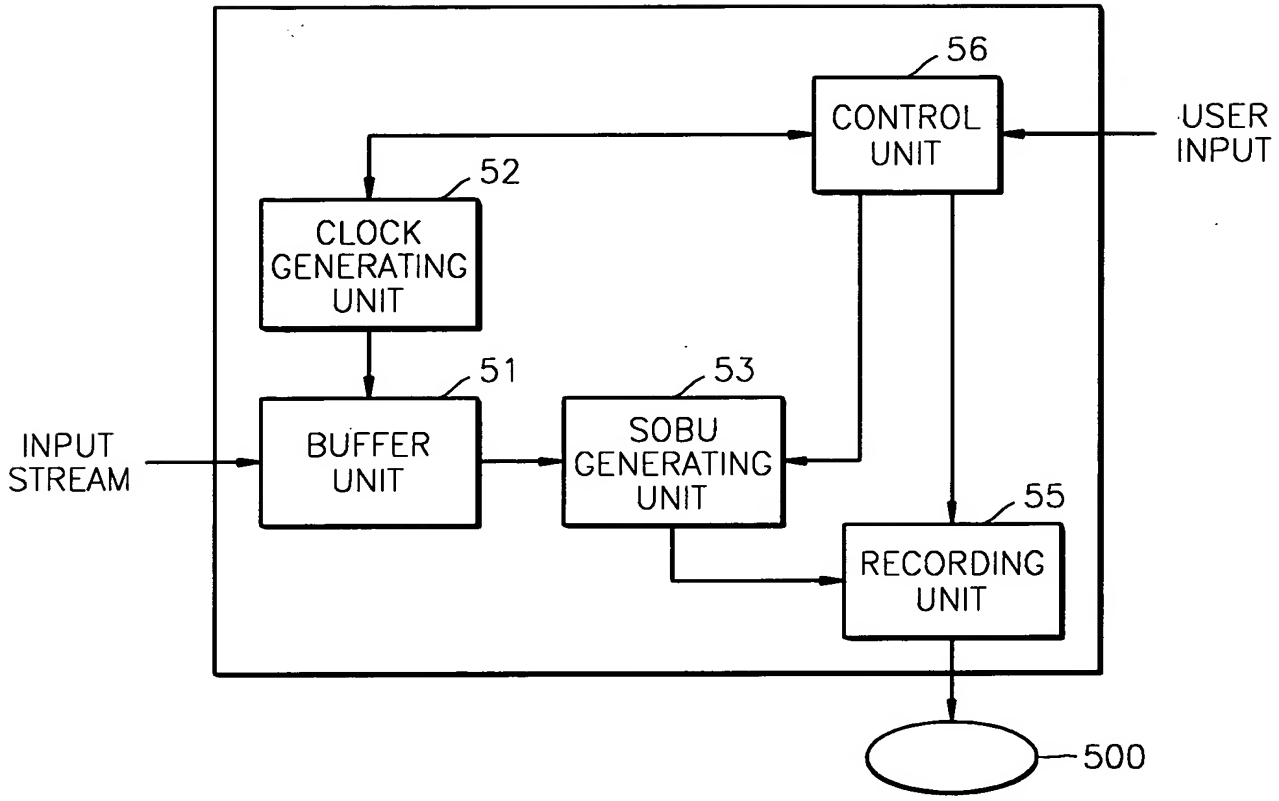

56
CONTROL UNIT
USER INPUT
52
CLOCK GENERATING UNIT
51
53
INPUT STREAM
BUFFER UNIT
SOBU GENERATING UNIT
55
RECORDING UNIT
500

FIG. 7

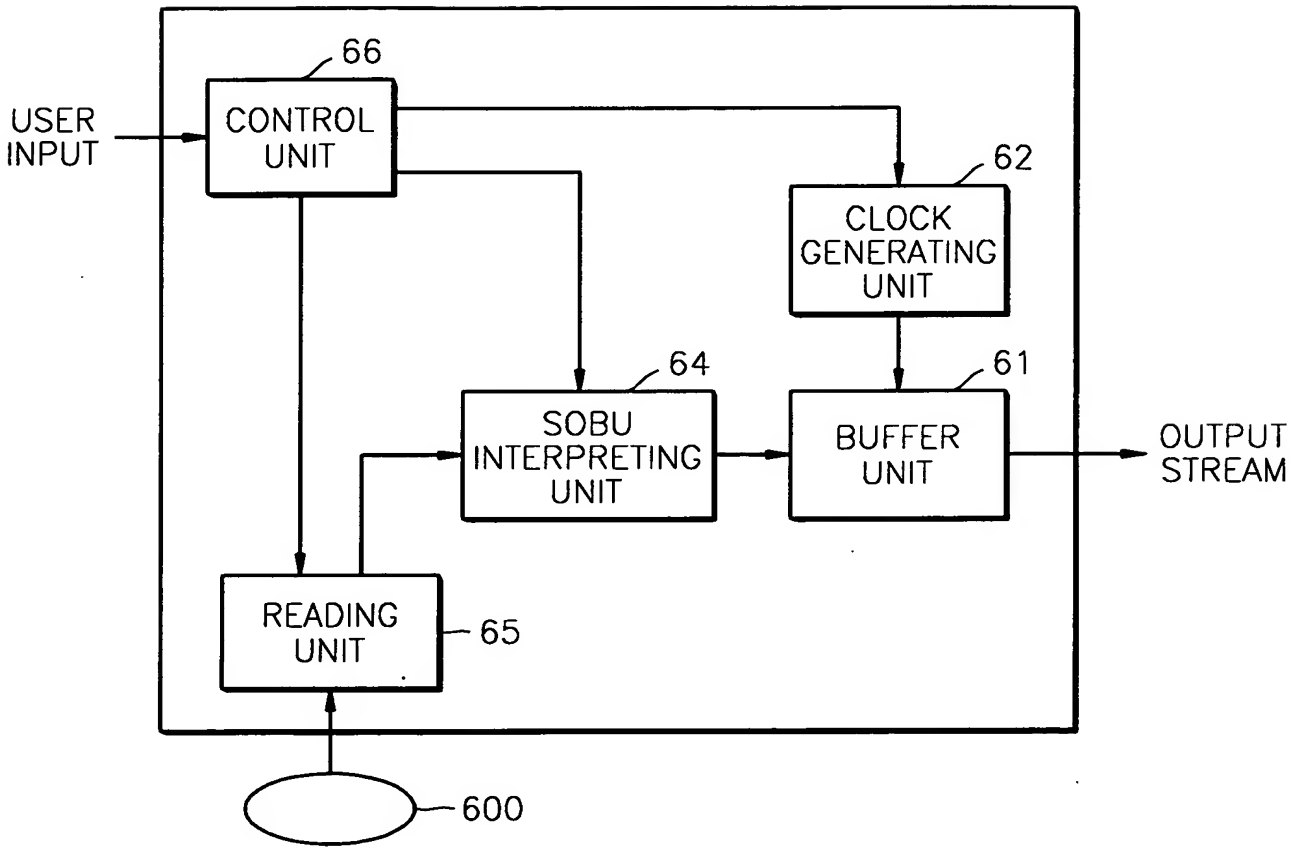
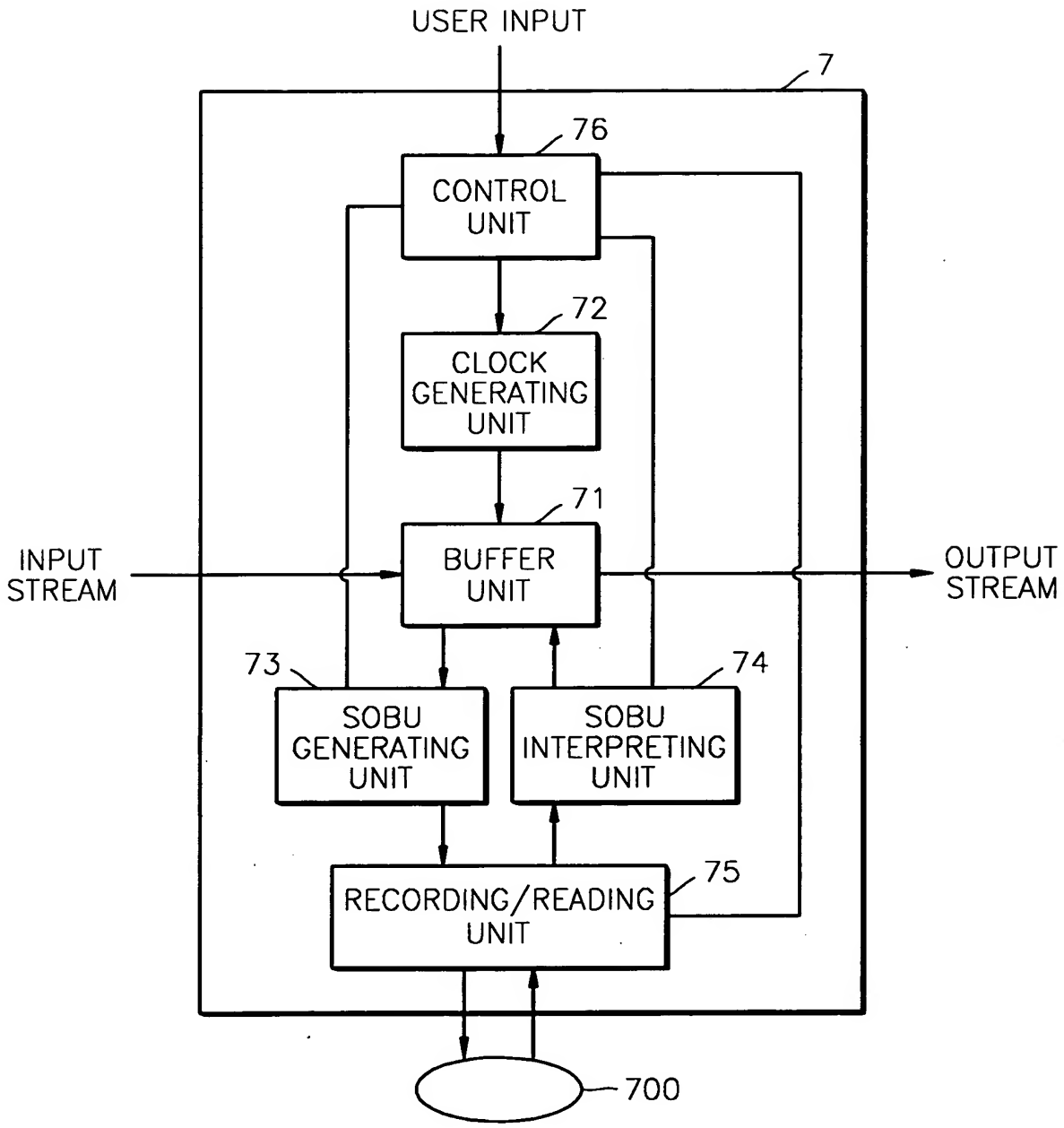

USER INPUT
66
CONTROL UNIT
62
CLOCK GENERATING UNIT
64
SOBU INTERPRETING UNIT
61
BUFFER UNIT
OUTPUT STREAM
READING UNIT
65
600

FIG. 8


USER INPUT
7
76
CONTROL UNIT
72
CLOCK GENERATING UNIT
71
INPUT STREAM
BUFFER UNIT
OUTPUT STREAM
73
74
SOBU GENERATING UNIT
SOBU INTERPRETING UNIT
75
RECORDING/READING UNIT
700